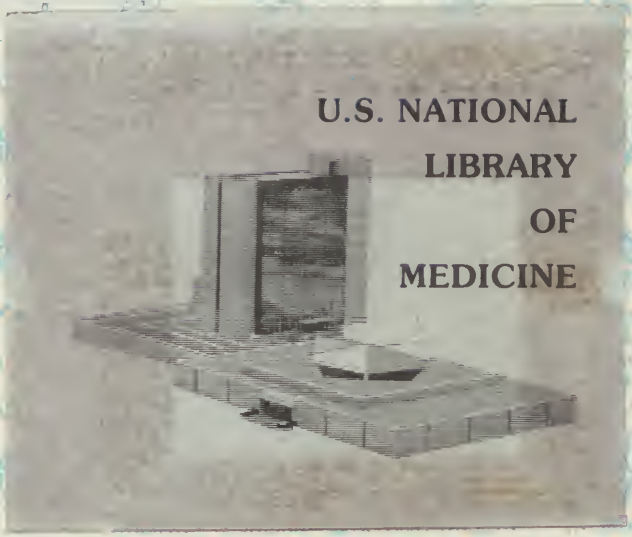

REPORT OF DUST STUDY

CONDUCTED IN GRANITE MONUMENT CUTTING PLANTS IN SOUTH CAROLINA

INDUSTRIAL HYGIENE DIVISION
SOUTH CAROLINA STATE BOARD OF HEALTH
1939

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BY
ROBERT M. BROWN, CHEMICAL ENGINEER

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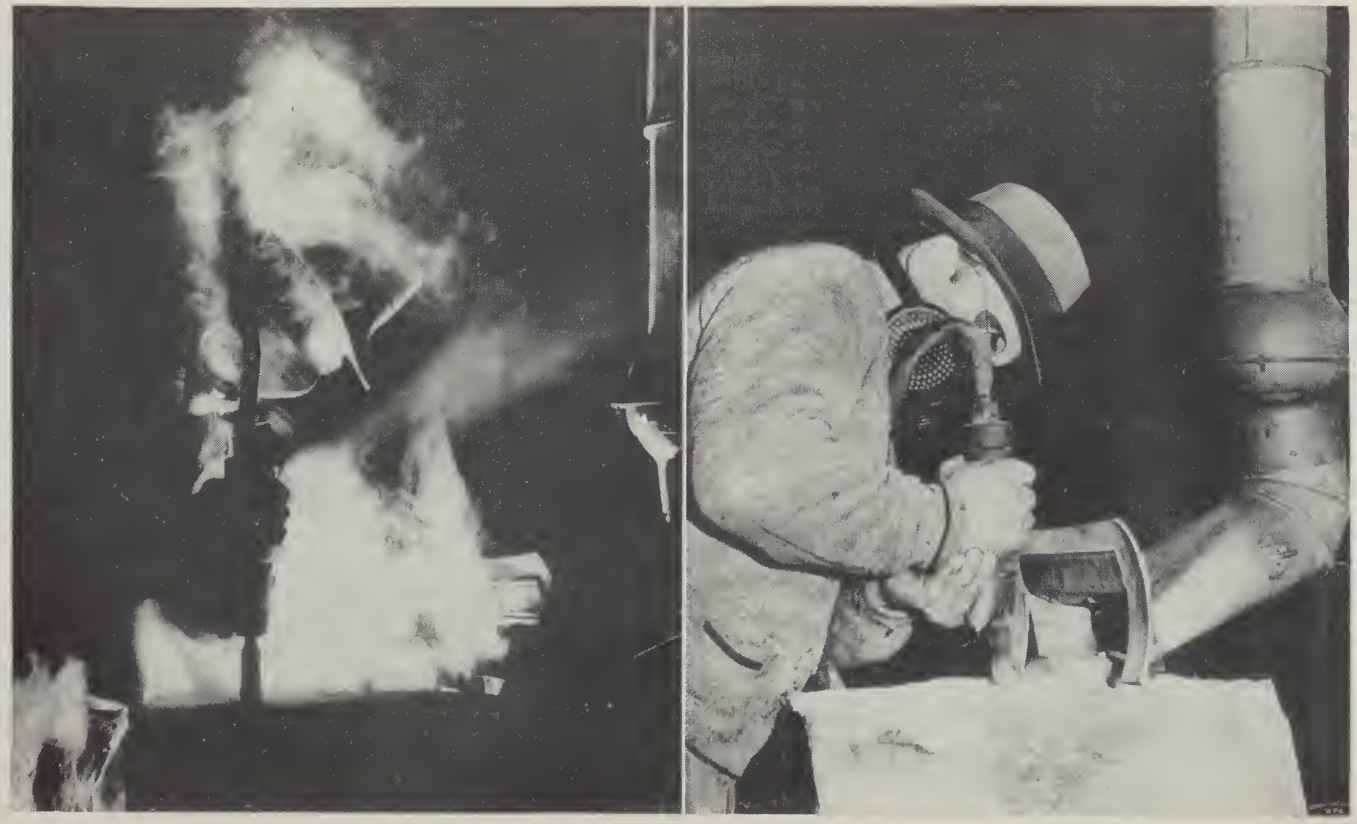


Control equipment not operating *Control equipment operating*

A striking picture of the effectiveness of dust control equipment

Courtesy of Div. of Occupational Hygiene, Mass. Dept. of Labor and Industries

Report of Dust Study Conducted in Granite Monument Cutting Plants in South Carolina

Clinical and *x*-ray examinations of men employed as granite cutters in various parts of the United States (1) have shown that there is a high incidence of silicosis complicated by tuberculosis (silico-tuberculosis) among those workers exposed to average dust concentrations exceeding a certain limit. This limit, established as a result of considerable clinical and engineering research and confirmed by independent investigations, is set at ten million particles (1) of dust per cubic foot of air for dust generated in processing granite. The study reported here was undertaken to determine the dust concentrations to which granite workers in South Carolina were exposed, and the relation of these concentrations to the threshold limit of ten million particles of dust per cubic foot of air (10 m. p. p. c. f.).

There were in South Carolina, at the time of a preliminary survey of all industries, (2) 35 granite cutting establishments operating in the State, employing 280 workers. The majority of the plants were very small employing less than five workers. Reference to Tables 1 and 2 will show the figures with relation to size of plants and distribution of workers. While 20 of the 35 plants employed five or less workers per plant, 120 of the 280 employees were accounted for by the three larger plants. The medium-sized plants comprising 34.3% of the total also employed 34.3% of the workers.

TABLE 1

DISTRIBUTION OF PLANTS ACCORDING TO NUMBER OF WORKERS

Total Plants	Total Employees	PLANTS WITH		
		1-5 workers	6-20 workers	20 or more
35	280	20 (57.1%)	12 (34.3%)	3 (8.6%)

Table 2

DISTRIBUTION OF WORKERS ACCORDING TO SIZE OF PLANTS

Total Plants	Total Employees	WORKERS IN PLANTS WITH		
		1-5 workers	6-20 workers	20 or more
35	280	64 (22.9%)	96 (34.3%)	120 (42.8%)

Since a study covering all 35 plants would have resulted in an unnecessary duplication of data and an unjustified expenditure of time, a representative portion of the plants were selected for study. Since preliminary surveys had been made of all granite cutting establishments in the State (2) it was possible to select 12 plants which were representative of the entire industry with respect to size, location and nature of operations. A composite analysis of the study of these plants is presented in this report.

Before entering any plant for the purpose of taking samples, the full permission and cooperation of the plant management was obtained. Samples of the dust in the air of the various workrooms were collected with the Greenburg-Smith Impinger (3). A sufficient number of samples were obtained to indicate accurately the dustiness of each operation. Samples were returned to the laboratory and, in all cases, counted within 24 hours by the technique developed and recommended by the United States Public Health Service. (3) These samples, representing the concentration of dust that the worker breathed, were collected at a distance of 10-18 inches from the worker's nose, this being as close as it was practical to hold the sampling tube without interfering with his work.

Table 3 presents a summary of the data for twelve plants studied.

FIGS. 1, 2. *Outside surfacing machines with exhaust equipment. Above, all-metal ducts, chip trap, bag-type collector inside. Below, flexible rubber hose duct, chip trap, and bag-type collector.*

Courtesy of Div. of Occupational Hygiene, Mass. Dept. of Labor and Industries

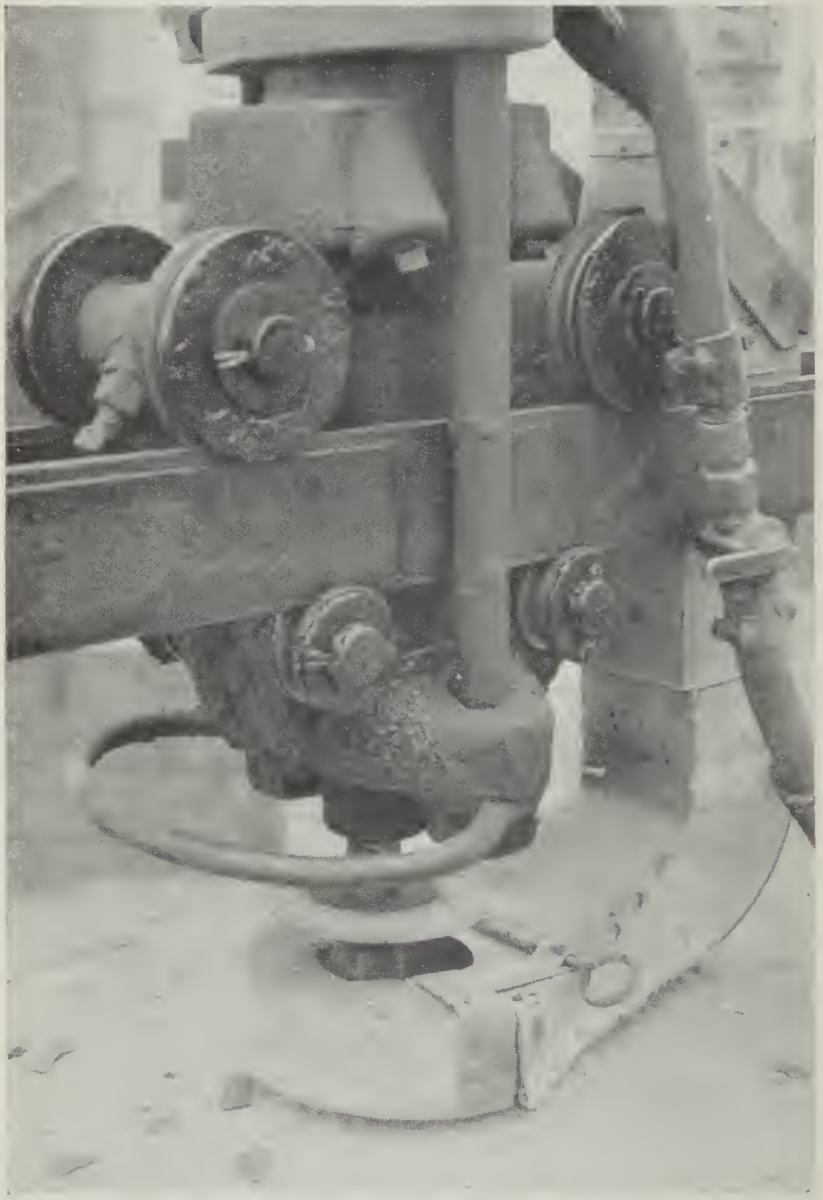


FIG. 3. *Encircling hood and baffle disc for surfacing machine. Encircling attachment is removed, by withdrawing pin, for all but four-pointing operation. Baffle disc (6" in dia.) is slipped over shank of chisel to prevent leaking air from dispersing dust.*

Courtesy of Div. of Occupational Hygiene, Mass. Dept. of Labor and Industries

TABLE 3

SUMMARY OF CONCENTRATIONS AND TOTAL EXPOSURES BY OPERATION

Operation	Dust concentrations (average of all samples taken)	Total samples taken for each operation	Total exposures for each operation
Surfacing	122.5	34	14
Pneumatic Hand Tools.	121.1	33	40
Sandblasting	88.1	33	14
General Air	66.6	19	102

Of the three principal granite processing operations, sandblasting produces the highest concentrations of dust and a much more dangerous dust. As presented in Table 3, however, the surfacing operation shows the highest average dust counts. This is due to the fact that some plants have controlled the dust from sandblasting and the average is lowered accordingly. With the exception of sandblasting, therefore, the surface cutting operation is the dustiest in the industry and is generally regarded as such. While the average figure for surfacing for the entire industry is 122.5 m. p. p. c. f. which exceeds the ten m. p. p. c. f. limit by 12 times, samples were taken at times when the limit was exceeded by up to 40 times.

Hand pneumatic tool operation, mistakenly believed by the trade to be much less serious an exposure than surfacing, ranks just as high in dust concentrations produced as the surfacing operation. As some workers practice it, it produces just as much dust as sandblasting. While in Table 3 the average for hand pneumatic tool operation for the whole industry is 121.1 m. p. p. c. f., maximum concentrations of more than six times this figure were obtained.

Commonly referred to as "the death house of the stone industry," the sandblast room is productive of large quantities of a very dangerous dust. While the dust produced from granite contains about 35% silicon dioxide (SiO_2) or "free silica," the dust produced from sand (practically pure silica) contains 95% to 100% "free silica." It is this free silica content of dusts which produces silicosis in stone cutters. Conditions produced by this dust in the lungs predispose the worker to tu-

berculosis. A sandblaster may be affected quickly, therefore, with a concentration of sand dust while a granite cutter may breathe granite dust in the same concentration, 10 m. p. p. c. f., with more or less impunity. It is a good practice to maintain the allowable limit of dust of the nature generated in sandblasting below five million particles per cubic foot of air. Referring again to table 3, the average figure for sandblasting is found to be 88.1 m. p. p. c. f. As has been mentioned previously, this figure would have been much higher had it not been for the fact that some plants had installed exhaust ventilation equipment to control the dust. Concentrations up to nearly 500 m. p. p. c. f. were found to exist in uncontrolled sandblasting.

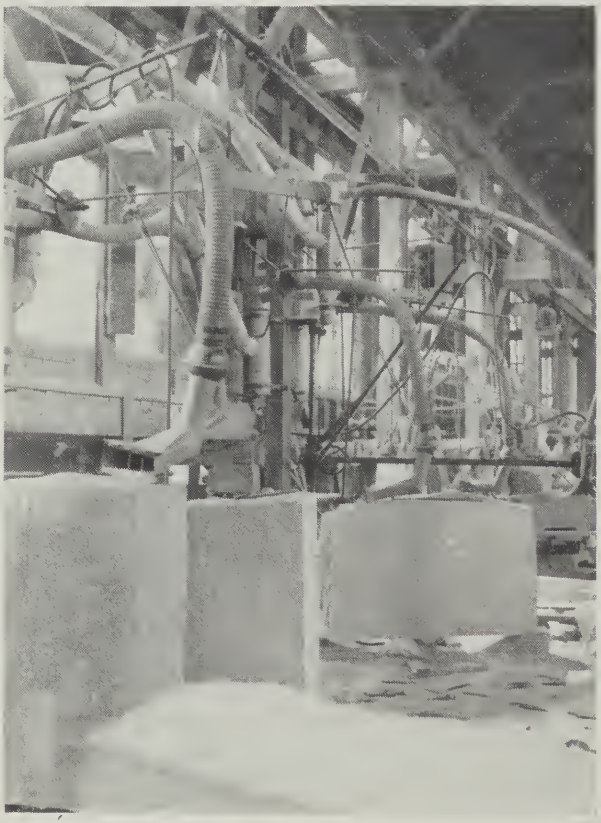
Probably the most startling figures of any are those which represent the concentrations of dust present in the general air while workmen were performing their operations. Employees in a granite cutting shed, whose work does not necessitate the use of pneumatic tools, are considered to have no significant dust exposure. It is a mistake to believe that plant laborers, cranemen, grinders, etc., and even the foreman himself, are safe from danger of breathing harmful quantities of dust. Unless a strong breeze is blowing through a plant, the general plant air is less apt to vary widely in dust content than the air in the immediate vicinity of the pneumatic tool worker. The average concentration during plant operation was found to be 66.6 m. p. p. c. f., which exceeds the allowable limit by almost seven times. Everyone within the plant working area breathes, on an average, a high concentration of dust.

Along with the dust concentrations in Table 3, the total number of samples taken for each operation and the total exposures for each operation are presented. The averages in this table cover all sections of the State, all types of work, and all conditions of operation.

There were 125 men covered by the study with 121 separate samples being taken, which number can be considered more than adequate.

FIG. 4. *Inside surfacing machines with individual dust control units. Each unit is complete in itself and is capable of handling one surfacing machine or two bankers*

Courtesy of Office of Industrial Hygiene, Vermont State Dept. of Public Health



FIGS. 5, 6. *Views of main line banker exhaust systems. Two types of exhaust hoods are used*

Courtesy of Div. of Occupational Hygiene, Mass. Dept. of Labor and Industries

TABLE 4

CONTROLLED AND UNCONTROLLED OPERATIONS IN PLANTS STUDIED

PLANT NO.	DUST CONTROL EQUIPMENT	UNCONTROLLED OPERATIONS
1	2 sandblast cabinets—exhausted with dustproof curtains.	2 surfacing machines, all pneumatic hand tools and drills.
2	Carborundum used in sandblast room with fan exhaust.	2 surfacing machines, sandblast room, all pneumatic hand tools and drills.
3	.....	1 surfacing machine, sandblast room, all pneumatic hand tools and drills.
4	.....	1 surfacing machine, sandblast room, all pneumatic hand tools and drills.
5	.....	2 surfacing machines, sandblast room, all pneumatic hand tools and drills.
6	Positive air pressure mask—(used without filter).	2 surfacing machines, all pneumatic hand tools and drills.
7	.....	1 surfacing machine, sandblast room, all pneumatic hand tools and drills.
8	2 sandblast cabinets—exhausted with dustproof curtains. Carborundum and steel shot used.	.....
9	.....	1 surfacing machine, sandblast room, all pneumatic hand tools and drills.
10	.....	2 surfacing machines, sandblast room, all pneumatic hand tools and drills.
11	.....	1 surfacing machine, sandblast room, all pneumatic hand tools and drills.
12	Sandblast cabinet—exhausted with partially effective curtain.	1 surfacing machine, all pneumatic hand tools and drills.

Table 4 indicates one of the reasons why dust concentrations in South Carolina plants are so high. No provision has been made at any granite monument cutting plant in the State for controlling dust by collecting it at the source of creation by means of local exhaust hoods and removing it from the workroom through exhaust pipes. Some plant managers have real-

ized the necessity for protecting sandblast operators and Table 4 shows that four of the plants studied had installed the equipment listed. Plant 8 appears to have eliminated the dust hazard from the sandblasting operation. In striking contrast to the list of control equipment in use is the column of Table 4 listing the uncontrolled operations in the 12 plants studied. These are the operations on which control equipment should be installed in order to eliminate the danger of the dust hazard from the processing of granite.

TABLE 5

S. C. DUST COUNTS COMPARED WITH COUNTS FROM NORTHERN PLANTS *

Operation	S. C. Study	U. S. Public Health Service Study in Northern Plants	Barre, Vermont, Study
Surfacing	122.5	44.0	26.8 ‡
Pneumatic Hand Tools	121.1	59.2	68.3
Sandblasting	88.1	6.2 †	8.7 †
General Plant Air	66.6	20.2	15.9

* Plants without control equipment.
† Sandblasting operation performed with ventilation.
‡ Some machines equipped with exhaust.

The existence of a real health hazard in the South Carolina granite industry is shown by the comparison of dust concentrations associated with operations in local plants with concentrations reported for similar operations studied in northern areas. (4) (5) In every case, South Carolina exposures greatly exceed those in the northern areas. The hazard of working in northern plants, if control equipment is not provided, is quickly admitted but it should also be realized that as great a hazard exists in the South Carolina industry.

PRACTICES ADDING TO DUST CONCENTRATIONS

Contributing to the extremely high dust concentrations just discussed are several factors and flagrant practices which if eliminated would considerably reduce dust exposures. Surface cutting was performed in almost all plants under the same

FIG. 7. *Main line banker exhaust system*

Courtesy of Office of Industrial Hygiene, Vermont State Dept. of Public Health

FIG. 8. *Pneumatic hand tool operator using exhaust hood*

Courtesy of Office of Industrial Hygiene, Vermont State Dept. of Public Health

shed with other operations, in some cases two large machines operating simultaneously. Without exception the exhaust of the surfacing machine was rigged up to blow the dust and chips from the surface of the stone. In rare instances an operator wet the stone before and during operation. Dust from this operation filled the entire plant, contributing greatly to the exposure of other workers.

In most cases, hand pneumatic tools were used without any dust control precautions. The exhaust part of the pneumatic hammer was used frequently to blow dust from the surface being worked, although in some cases brushes were used to clean the working surface. "Jumbo bumpers" (large and heavy hand pneumatic hammers) were used in hand surfacing operations creating greater dust concentrations than the machine surfacing. Each man was exposed to the dust his fellow worker created as well as to that arising from his own work.

Sandblasting was performed in the same careless manner, in some cases being done openly in the workroom itself. Even where a separate room was provided, no provision was made in the majority of cases, to prevent the diffusion of dust into the workroom. Only in the instances presented in Table 4 were the operators provided with effective protection. In many places where exhaust provision for sandblast rooms was made, a change of wind direction blew the dust right back into the general plant atmosphere.

The dustiness of the general air of the plants was much greater than would be expected. It is frequently claimed that since southern sheds are of such open construction the breezes quickly remove all dust. The figures show that such is not the case. Even in cases where strong breezes pass through the sheds and do remove the visible dust from the general air, the workmen in performing their various operations—surfacing or hand working—have to keep their faces so close to the stone that the dust always passes their noses in getting away. Foremen, cranemen and laborers, in a majority of the cases where studies were made, breathe a hazardous amount of dust. In many places great piles of chips, dust and stone débris were allowed to collect in plants and over reserve stocks of stone and equipment from whence dust was stirred up by the wind

and by movement of men and materials. This is an important source of general air dustiness.

RECOMMENDATIONS

At the completion of each individual plant survey a report with recommendations was made to the management of each establishment. In all cases an effort was made to provide a set of recommendations particularly applicable to the plant under consideration. Following is a composite list prepared from the list of recommendations to individual plants. They are presented as general recommendations for all plants.

1. Install a local exhaust ventilation system for the surfacing machines and for all pneumatically operated hand tools. Provide local exhaust for grinding wheels, especially when they are dressed down.

2. Provide an effective dust collector for the dust removed through the exhaust ventilation system, and adopt a good practice for disposing of the collected dust.

3. Install a sandblast curtain built into an exhausted and otherwise air-tight sandblast room so that the operator can work outside the room behind the curtain. In operations where the use of a curtained sandblast room is impractical, provide the worker with a positive pressure sandblast helmet and supply at least five cubic feet per minute of clean air to this helmet. In case compressed air is used as the helmet supply it will be necessary to place in the supply line a filter which will remove oil, dust and compressor fumes from the air breathed.

4. Provide an effective collection and disposal system for the dust removed from the sandblasting operation. When a curtained sandblast room is provided, lifting the curtain or entering the room to inspect the work should be prohibited until the room has cleared of dust.

5. Eliminate the present practice of removing dust from the work by means of the "blow-off" through use of the pneumatic tool exhaust. In cases where provision has not been made for removing dust and chips through an exhaust hood or for washing them away with water the dust should be brushed off. Dry brushing is a dusty operation but is less dangerous than practicing the "blow-off."

FIG. 9. *Airtight, exhausted sandblast cabinet with movable curtain. Operator stands outside and blasts stone through curtain*

Courtesy of Div. of Occupational Hygiene, Mass. Dept. of Labor and Industries

FIG. 10. *Wet drilling device for control of dust generated in drilling operation*

Courtesy of Div. of Occupational Hygiene, Mass. Dept. of Labor and Industries

6. Use water on all rough work where local exhaust ventilation has not yet been provided.

7. Insist on good "housekeeping" in the plant. In other words, do not allow dust to accumulate on floors, rafters and unused stone and equipment. Accumulated dust is an important source of contamination which can easily be eliminated.

8. Instruct the men as to the maintenance of equipment and practice of the measures outlined above, *i. e.*, educate them as to the safety measures they must practice to protect their own health.

(In cases where plants are very small and, due to economic status and intermittency of operation, it is not feasible to install local exhaust ventilation equipment on the surfacing machine and for pneumatic hand tool operations, the following recommendation is made) :

9. As a less desirable alternative, the surfacing operation should be isolated and the operator should be provided with an air line respirator or a filter respirator of a type approved by the U. S. Bureau of Mines for use against silica dust; and all pneumatic hand tool operators and drillers should be provided with approved respirators. Provision should be made gradually for the eventuality that some day complete control of the dust hazard will be required in South Carolina.

In addition to these recommendations, two recommendations of a medical nature were made to all plants:

1. Have a pre-employment physical examination made of each man to be employed. This should be a complete examination including an *x*-ray of the chest and a serological test for syphilis.

2. Have a periodic physical examination of each employee made at least once a year. This examination should be as complete as the recommended pre-employment examination.

Every effort has been made to make these recommendations applicable to all plants. No plant owner or manager should feel that these recommendations do not apply to him or that his plant is an exception. There is a definite responsibility in every case.

Individual plant operators have expressed their approval of these dust control measures and have stated their willing-

ness to take any steps necessary if *all* similar plants will do likewise. Simultaneous action by all concerned is obviously the ideal approach to the solution of this problem, although it has been shown, by experience in other states, that dust control measures, considered as a long term investment, are economically advantageous to individual plants.

CONTROL OF GRANITE DUST BY ENGINEERING METHODS

It is only by employing engineering methods that granite dust in the workroom air can be maintained below the safe limit of ten million particles per cubic foot of air. This end is accomplished by the installation of *designed* exhaust ventilation equipment supplying suction devices for each surfacing machine and each individual banker. Examples of such equipment in actual operation are pictured in Figures 1 through 12.

For the surfacing operation an exhaust hood similar to that in Figure 3 is recommended. (6) By means of the movable pin, the front encircling attachment can be removed during all but the four-pointing operation. The heavy screen allows full view of the work during the time the encircling attachment is in use. The baffle disc (6″ in diameter made of heavy multi-ply rubber or of leather) is slipped over shank of chisel to prevent the air, leaking around shank of chisel, from dispersing dust. Needless to say, the machine exhaust is *not* directed on the stone but away from the work in order to interfere in no way with the suction hood. For complete satisfaction and efficient operation of this hood an air flow of 600 cubic feet per minute is necessary. (6)

For hand pneumatic tool operation a hood similar to that in Figure 5 or that in Figure 6 is recommended. By means of a flange on the hood, the dust collection efficiency of the hood is increased about 25%. (5) With this type of apparatus an air flow of 400 c. f. m., maintaining an air velocity of 200 ft. per minute at a point six to seven inches in front of the center of the hood, is necessary. (6)

Main duct size and layout will depend upon the number of bankers and surfacing machines being exhausted. Branch

FIG. 11. *Bag-type collector with cyclone separator for removing chips and coarse particles. (Cyclone is useless for collecting fine particles.)*

Courtesy of Div. of Occupational Hygiene, Mass. Dept. of Labor and Industries

FIG. 12. *Two sizes of bag-type collectors. Old-fashioned settling box at right has been discarded*

Courtesy of Office of Industrial Hygiene, Vermont State Dept. of Public Health

ducts may be either of sheet metal with swivel joints or of flexible rubber tubing. Branch ducts of less than five inches inside diameter should not be used. (6) (See Figures 1, 2, 4, 5, 6, 7.)

Fan size and speed of operation together with motor size will depend upon the size of the system and the amount of air which will have to be moved to give the necessary suction at the individual hoods.

An efficient and economical collector must be provided to take care of chips, coarse particles, and fine dust. As a means of entrapping the fine dust particles, a cyclone separator is useless but is of great value when included to remove small chips and coarser particles, thus saving undue wear on the final collector. A collector of the cloth bag filter type is necessary to entrap the finest and most dangerous dust satisfactorily and economically. Collectors of this type are illustrated in Figures 11 and 12. Disposition of the dust taken from the collector must be provided for to remove it from the plant vicinity.

Examples of installation cost of control systems as herein outlined are as follows: (5)

"The comparative costs (sale price) of a number of dust removing systems, installed complete to operate with hoods, rubber suction hose, support for suction hose, chip traps, sheet metal and main pipe, cloth type filter, fan, motor and drive are:

a. Two banker system (800 c.f.m) 3 h. p. motor, $465.00.*

b. Seven bankers and two large surface cutters (4,400 c.f.m), 15 h. p. motor, $2,319.00.*

c. Eight bankers and two large surface cutters (4,800 c.f.m), 20 h. p. motor, $2,261.00.†

d. Ten bankers only (4,000 c.f.m), 15 h. p. motor, $2,120-.00.†

e. One surface cutter single unit (600-800 c.f.m), $550.00.†

f. One banker single unit (400 c.f.m), $315.00.* "

* Includes electric wiring.

† Does not include electric wiring.

Equipment of this nature has proven its economic worth to those companies which have installed it. It is practical, eco-

nomical, and aids the workers in producing more efficient work.

The information given here has been meant to cover only the main points of dust control equipment and its installation. Additional information and data can be obtained upon request from the Industrial Hygiene Division of the S. C. State Board of Health.

SUMMARY

A dust study was conducted in 12 of the 35 monument and tombstone cutting plants in South Carolina. Of a total of 280 men employed, 125 were covered by the study. A total of 121 dust determinations was made.

Contrary to popular belief among the granite cutting trade, high concentrations of dust were found in every stone cutting operation. In fact the average concentrations for the majority of the individual plants and for the industry as a whole were dangerously above the maximum allowable limit of 10 million particles per cubic foot of air for granite dust.

A comparison was drawn between dust concentrations found in plants of northern areas by the U. S. Public Health Service (1) (4) and in Barre, Vermont (5) by the Industrial Hygiene Division of the Vermont Department of Public Health. In every instance South Carolina figures were considerably higher. No control equipment other than for the sandblasting operation was found in any plant.

A discussion of the contributing causes to such high concentrations of dust in South Carolina is presented. Recommendations, a collection of those made to each plant at the completion of the individual study, are made as recommendations to the entire industry.

A brief discussion of the engineering control of granite dust is presented. Specific control equipment is recommended and figures relative to cost of installation are given. Illustrations of equipment installed and operating in other granite cutting areas are shown.

It is very important that each plant do its share in providing exhaust ventilation facilities to remove the dust generated at its source and maintain individual exposures below the limit of ten million particles per cubic foot of air.

ACKNOWLEDGMENTS

Grateful acknowledgment is made of the cooperation given by the officials and workers of the plants in which this study was made. Appreciation is expressed to the Division of Occupational Hygiene of the Massachusetts Department of Labor and Industries and to the Office of Industrial Hygiene of the Vermont State Department of Public Health for the pictures used herein. Thanks are given to the plants in which the pictures were taken for allowing them to be used. Appreciation is also expressed to Sanitary Engineer J. J. Bloomfield and Associate Public Health Engineer R. T. Page of the Industrial Hygiene Division of the U. S. Public Health Service for help rendered in preparing this report.

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